THE DARST CREEK OIL FIELD, GUADALUPE COUNTY, TEXAS

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Dean of the Graduate School.

August 24, 1932.

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THESIS

Presented to the Faculty of the Graduate School of
The University of Texas in Partial Fulfill-
ment of the Requirements

For the Degree of

MASTER OF ARTS

By

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(Austin, Texas)

Austin, Texas

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PREFACE

The writer was employed almost continuously by the Humble Oil and Refining Company as resident geologist and scout in the Darst Creek field from September, 1929, when the field had but two producing wells until June, 1930, when it had one hundred-fifty-eight producing wells; and he has had intermittent contact with the field since that time. He, therefore, feels that he has sufficient knowledge of this field to make it the subject of his thesis in partial fulfillment of the requirements for a Master of Arts degree from the University of Texas.

The data used in this thesis are compiled from those obtained by the writer and by other geologists, scouts, and employees of the various oil companies, to whom the writer is indeed grateful. He is especially indebted to the officials of the Humble Oil and Refining Company for their permission to use these data; to Messrs. L. T. Barrow and L. F. McCollum for their criticisms and suggestions; to Miss Katherine Liljegren for her assistance in preparing this manuscript; to W. E. Sanders for drafting the accompanying plate and figures; and to Messrs. E. H. Sellards, F. L. Whitney, and F. B. Plummer for their criticisms and suggestions and for accepting the sponsorship of this thesis.

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ABSTRACT

The Darst Creek Oil Field, the fourth Edwards limestone field in southwest Texas, was discovered July 18, 1929, in eastern Guadalupe County (fig. 1). It is located along one of a series of "en échelon" faults parallel with, and southeast of, the Balcones Fault zone of Texas.

After migrating up-dip from the southeast, the oil in this field was trapped in the upper 50 feet of the porous Edwards limestone, which was faulted into juxtaposition with the impervious beds on the downthrown side of the fault. In addition to wells producing from the Edwards, several produce from fault plane cavities, and two supposedly are producing from reworked serpentine deposits. The maximum vertical displacement along the fault is calculated to be approximately 550 feet on top of the Austin chalk.

The surface beds in the area are middle and upper Indio sandy clays of lower Eocene age. Aside from fault planes, the structure is evidenced on the surface by steep dips, a decided down-dip swing in the Indio-Carrizo contact, and a repetition of upper Indio.

The productive area of the field, including the Appling area to the northeast, consists of approximately 1670 acres. It is 6 miles in length and in places exceeds 4000 feet in width. Of the 291 wells drilled in the area, only 19 are dry holes. The total production through December 1931, was 19,700,340 barrels. The oil has a paraffin base, a deep green

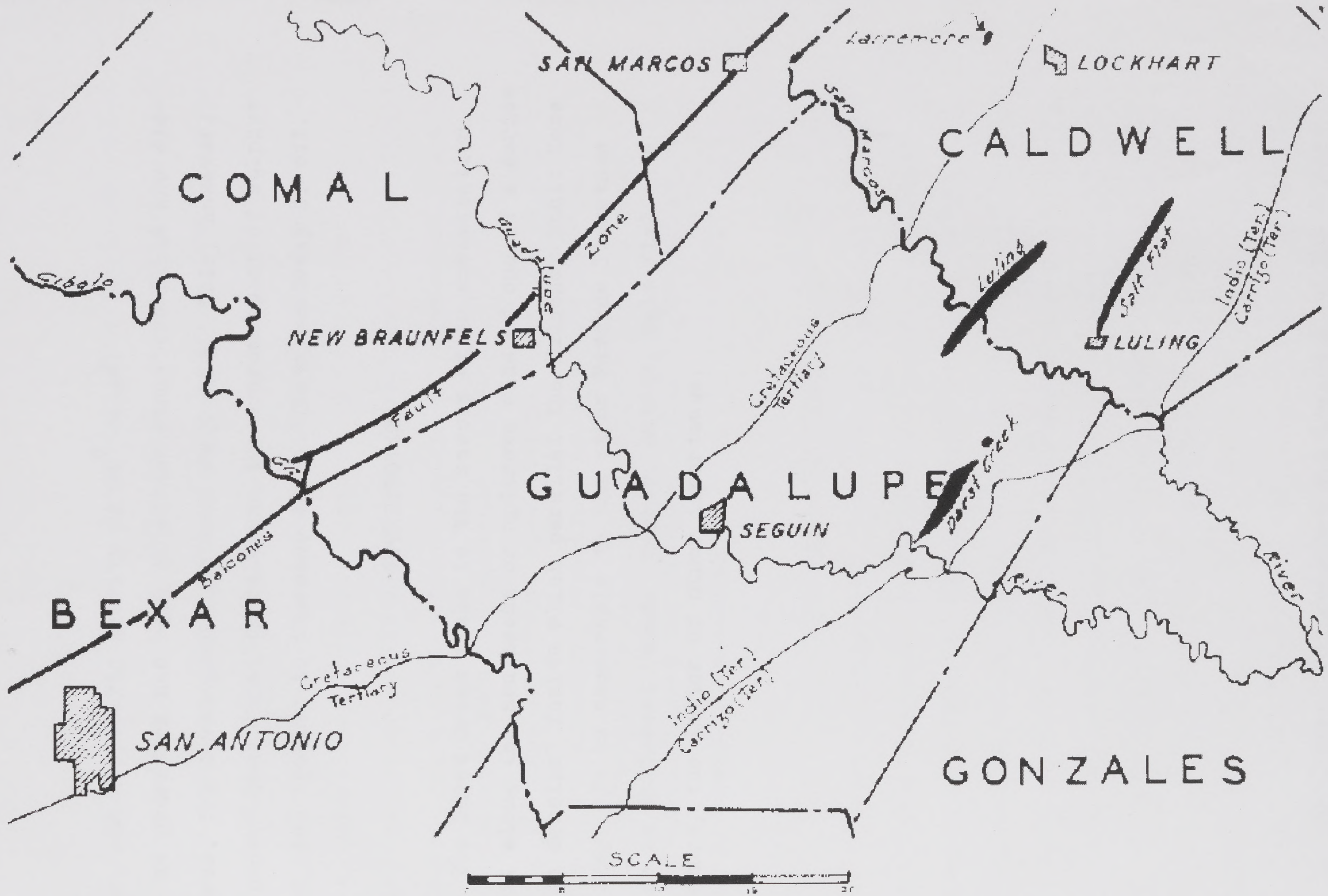

FIG. 1.—Geological and geographical location of Darst Creek field, Guadalupe County, Texas.

color, and a specific gravity of 36° Baumé.

As proration has been in effect since the field was discovered, the development has been very slow. This, however, has proved beneficial by delaying the encroachment of sulphur water and tending to increase the ultimate recovery of oil.

INTRODUCTION

The Darst Creek field is the result of an accumulation of oil along the southeast or upthrown side of one of a series of "en échelon" faults which parallel the Balcones Fault Zone of Texas. It is comparable to the other Edwards limestone fields in southwest Texas; namely, Luling, Salt Flat, and Larremore, the latter of minor importance.

Fig. 1. Geological and geographical location of the Darst Creek field, Guadalupe County, Texas.

The field is located in eastern Guadalupe County about 12 miles east of Seguin and 45 miles northeast of San Antonio. As it lies approximately 23 miles southeast of the Balcones Fault zone, it is included within the geologic province known as the Texas Gulf Coastal Plain. The topography of the field and surrounding territory conforms to that of the plain, which is a monocline gently dipping to the southeast. The highest, lowest, and mean elevation of wells within the field are 554, 419, and 490 feet, respectively.

The area is drained by Guadalupe River and several intermittent tributaries, including Darst Creek, for which the field is named. Federal highway No. 90 from San Antonio to Houston crosses the southwestern end of the field and makes it easily accessible.

HISTORY AND DEVELOPMENT

Oil was discovered in the Darst Creek field July 18, 1929, when the Texas Company's No. 1 Dallas Wilson came in flowing pipe-line oil at the rate of 1000 barrels per day. The field is unique in that this was the first test drilled on the structure. The fault had, however, been previously shown on the map accompanying Professional Paper No. 126, by Alexander Deussen, published in 1924, and had been remapped and checked in 1928-1929 by other geologists who regarded the well as favorably located for testing the structure.

Upon completion of the well, operators in the area, apparently believing that the prevailing condition of over production would soon be relieved, delayed development of the field until January, 1930. At this time an umpire took charge and invoked a systematic method of drilling and producing wells, which was agreeable to all. His first schedule, issued January 1, allowed the field a daily production of 15,369 barrels, or 68% of the 22,397-barrel potential. This allowable was apportioned among the operators according to their proven 20-acre units, and the average potential production of wells in each unit. Every month, however, a small amount was deducted from the unit allowance to prorate among wells making 50% or more water and to other wells affected by the resulting drainage. The daily potential increased from 22,397 barrels on January 1, to a peak of 245,864 barrels on May 1. The prolonged condition of over production, however, caused the percentage allowable to be reduced from 68% on January 1 to 9% on May 1. This reduction perhaps led to dissatisfaction among operators, who broke proration during the late summer and early fall of 1930. The pipe line runs concordantly increased from a daily average of 28,201 barrels during June to a daily average of 50,763 barrels during October, and these runs hardly surpassed those of August, September, and November of the same year. As a result the Railroad Commission took control and beginning October 29, restricted the daily allowable to 30,000 barrels. This amount remained unchanged until March 14, 1931, when it was reduced to 20,000 barrels. Then on October 17, 1931, it was further reduced to 18,000 barrels at which it remained through December 1931.

Generally speaking, proration has been satisfactorily carried out in the Darst Creek field. It has not only kept production down but has brought about the orderly development of the field and will probably result in the ultimate production of more oil at a lower cost than would have been possible had the usual haphazard methods of development and production been followed.

Activity within the field was stimulated several times by the completion of a well extending the productive area, or by one having an unusually large initial production. This was particularly true when the Magnolia Petroleum Company's No. 1 M. E. Roamel came in flowing at the rate of 41,928 barrels daily, extending the field 1500 feet northwest. Another such episode occurred when the Camp et al No. 1 Sue E. Denman was completed as a 6000 barrel well, extending the field one mile southwest. A number of wells, notably on the Christopher Knoblock tract, had large initial productions, but their rates soon declined to normal. The condition explaining these latter wells is discussed in detail under <u>Producing Horizons</u>.

Fig. 2. -Looking northeast from the Texas Company's Christopher Knoblock lease, Darst Creek field, Guadalupe County, Texas.

AREAL GEOLOGY

Surface beds in the Darst Creek area are Indio, or basal Wilcox, sands and sandy shales of lower Eocene age. This formation outcrops over a strip of land from 8 to 15 miles wide extending northeast and southwest across Texas. It can be divided into three general zones; namely, a lower, sandy shale, a middle sand, and an upper sandy shale. These zones, in turn, can be locally subdivided, yet few of the subdivisions can be mapped over large areas. They either merge into one another, lense out, or change lithologically so abruptly that they cannot be identified.

The field is located within the upper sandy shale zone, but any subdivision of this zone is practically impossible, as it is so broken up by the Darst Creek fault. It is evident, nevertheless, that the beds immediately northwest of the surface fault show a decided similarity to uppermost Indio beds, which normally come in contact with the Carrizo sand, the next younger formation outcropping one mile downdip. This contact between the red sandy shale of the Indio and the deep white sand of the Carrizo reflects the faulting in the field by a decided down-dip swing away from the fault, and in itself, is sufficiently pronounced to incite a geologist to search to the northwest for an explanation of it. To the southwest, where the contact swings back toward its normal position, there is an offset in it, which could only be caused by a fault cutting slightly down-dip. This offset definitely assures closure on the southwest end of the fault. To the northeast, along strike of the offset, a perfect fault exposure is found in a small ravine on the Sallie Wilson lease. This exposure shows the strata on the downthrown side of the fault dipping toward the fault to within two feet of the plane where there is an abrupt updrag of the strata. On the upthrown side of the fault the strata dip normally to the southeast, except for the two feet adjacent to the plane where they have an abrupt downdrag into the fault. The fault strikes N. 35° E. and dips 65° to the northwest. Northeast of this exposure numerous steep dips, a repetition of beds, and several minor fractures help to place the approximate location of the surface fault. Closure on the northeast is not proven, but is strongly indicated by the updip swing of the Indio-Carrizo contact toward the fault plane in the ficinity of the Knodel lease. At this point, however, the

Manford fault causes the contact to swing out from Darst Creek around its own southwestern end.

The area is comparatively easy to map. Only a few places are covered with gravel or alluvial deposits; consequently, exposures are numerous.

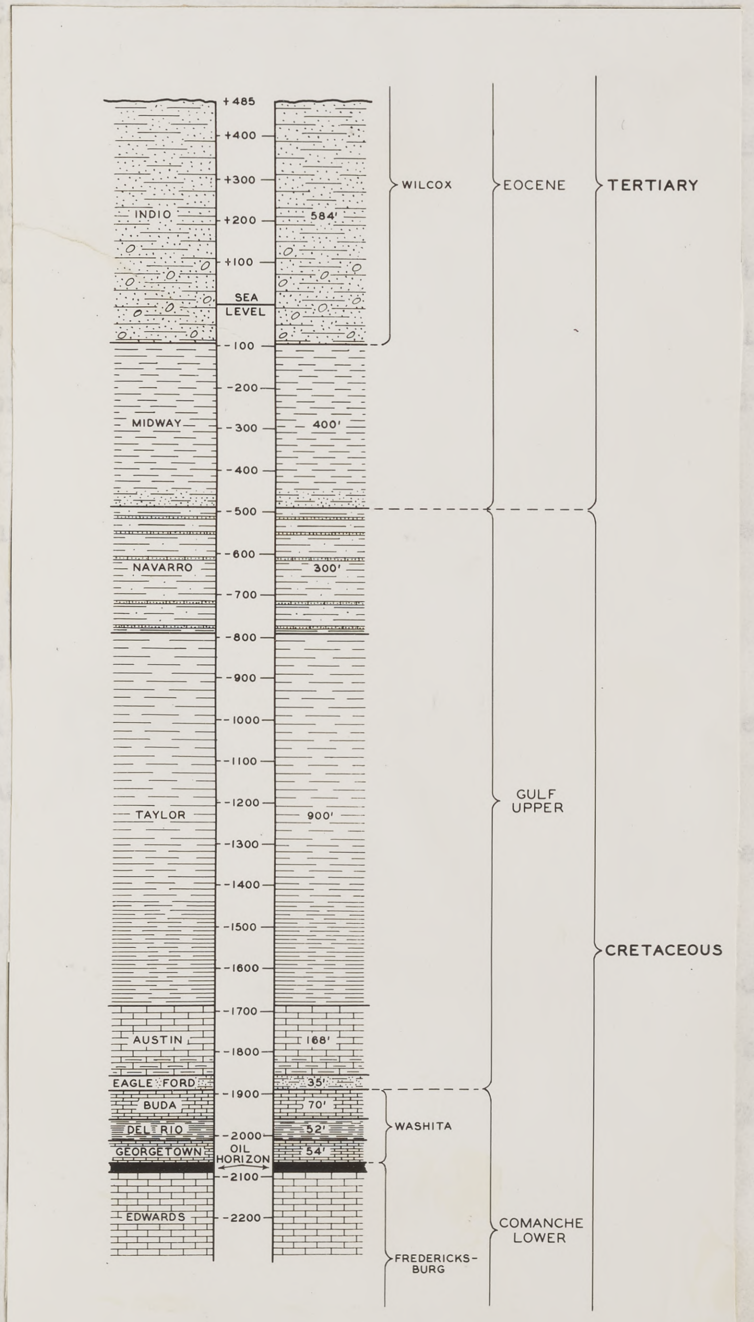

Fig. 3. Generalized well section of the Darst Creek field, Guadalupe County, Texas.[1]

STRATIGRAPHY

Unconformities

The stratigraphic section of the Darst Creek field includes sediments from Indio (early Tertiary) age down into Edwards (Comanche or Lower Cretaceous) age. The upper formations of this section from the surface down, are Indio, Midway, Navarro, and Taylor, which have an aggregate thickness of 2100 feet. Except when occasional "boulders" are encountered, these formations are usually drilled with a fishtail bit. The "boulders" or concretions, however, are of such induration, that it is often necessary to drill them with a roller bit. The remaining formations of Austin, Eagle Ford, Buda, Del Rio, Georgetown, and Edwards have an average aggregate thickness of 400 feet, and, with the exception of the Del Rio, are drilled with a rock bit.

Despite the scarcity of evidence, it is generally conceded that two and possibly three unconformities exist in the section drilled in this field. The uppermost is the Navarro-Midway contact, which represents the time interval between Cretaceous and Tertiary deposition. This break is evidenced by the abundance of glauconite in the basal Midway and by the striking faunal differences in the two formations. The Buda-Eagle Ford contact seems unconformable as it not only represents

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[1]The thickness of the formations above the Austin chalk were averaged from those of several wells as determined by the Paleontologic Laboratory, Humble Oil and Refining Company, Houston, Texas.

the time interval between the deposition of the Comanche and Gulf series, but it reveals the absence of a southwest Texas time equivalent of the Woodbine sand of northeast Texas. This condition implies that southwest Texas was probably subjected to erosion during Woodbine times, thereby resulting in an unconformity. In support of this, the exposed contact of the Buda and Eagle Ford formations is irregular, showing numerous furrows. The Edwards-Georgetown contact has been proved unconformable at the surface in Hays and Comal counties.[2] This unconformity is proved by the absence of certain phases of basal Georgetown in some places and the presence of it in others. This irregularity indicates that a period of erosion followed the Edwards limestone deposition and left an irregular surface. An older phase of the Georgetown limestone was deposited in the topographic lows and a somewhat younger phase over it which covered the topographic highs. Other evidence of the erosional surface includes inliers of Georgetown, outliers of Edwards, and gravel and petrified wood supposedly in place within the Edwards outcrop. The inliers of Edwards formation and outliers of Georgetown formation are explained by this unconformity which results in irregular thicknesses of the Georgetown. It is believed

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[2]Presented by Dr. F. L. Whitney, Department of Geology, University of Texas, Austin, Texas, in a talk on Hays and Comal counties, given before a joint meeting of the Southwestern and San Antonio Geological Societies in October, 1931.

that the erosional surface is probably confined to areas near the outcrop of the Edwards and Georgetown formations, since no evidence of an unconformity has been reported from the subsurface.

Aside from local veneers of alluvium and gravel and one small area of white sand, the surface of the Darst Creek field is covered with red sandy shales of the Indio formation of Tertiary age. The age of the white sand is questionable. Some geologists consider it a repetition of the Carrizo on the downthrow side of the fault because of its white color, coarse texture, and loosely consolidated character. Other geologists call the sand Indio because it is underlain by sandy shale of middle Indio character rather than by shale and boulders of upper Indio as would be the case if it were Carrizo. This sand is found on and near the D. D. Baker lease in the field.

The formations encountered in the Darst Creek wells are described in the following paragraphs. With the exception of the surface formation, this description is based upon the appearance of cores and cuttings from the wells.

TERTIARY SYSTEM

Indio: The upper division of the Indio is exposed in the Darst Creek field. The beds included in this division are composed of variegated sandy shales and boulders, which weather to brownish-red and yellow. The formation has an approximate thickness of 1200 feet, but usually only 548 feet are penetrated by wells within the field. This thickness is not constant, however, as the surface elevation and the proximity of wells to the fault plane may alter it considerably.

The formation is highly cross-bedded and contains many traces of lignite. These characteristics indicate its deposition in shallow lacustrine waters, whereas fossils in the shales and concretions indicate their deposition in shallow marine waters.

Midway: Underlying the Indio sandy shales are sediments of Midway age. They consist of blue, sticky, micaceous shales and grey silts, occasionally interstratified with laminae of glauconite and sand. The glauconite is found in such quantities near the base of the Midway that it is a useful marker for correlating subsurface data. The formation averages 400 feet in thickness, which may vary according to the proximity of wells to the fault plane. The abundance of microscopic fossils and the argillaceous content of the formation suggest its deposition in a shallow epicontinental sea.

CRETACEOUS

Navarro: Cores and cuttings from this formation reveal it to be a blue, calcareous, unctuous shale containing lenticular sand, sandstone, and arenaceous limestone. The Navarro is very similar to the underlying Taylor formation, and unless beds containing the fossil Exogyra costata Say are present in the Navarro, it is practically impossible to make a megascopic distinction between the two. They are, however, easily distinguished microscopically. The Navarro has an average thickness of 300 feet and, judged from its lithology and fossil content, seems a comparatively shallow-water, marine deposit.

Taylor: The Taylor consists of approximately 850 feet of massively bedded blue-grey marls and a basal chalk bed which varies in thickness up to 50 feet. This basal bed is known as Taylor chalk and is frequently mistaken for the underlying Austin chalk, as both are white and have a tendency to whiten the grey color of the drill fluid. The Taylor chalk, however, is softer and can be pulverized between the finger tips.

Both the Taylor and the Austin contain fault-plane cavities that serve as traps for oil which escapes from the main pay horizon and migrates up the fault plane. This condition is discussed in detail under Producing Horizons. Like the Navarro, the lithology and fossil content of the Taylor indicates deposition of its strata in comparatively shallow, marine waters.

Austin: The top of the Austin chalk is the first dependable subsurface horizon marker in the field. It is a comparatively hard, white, glauconitic chalk, interstratified in some places with thin beds of white marl. It contains an abundance of megascopic and microscopic fossils, has a noncrystalline texture, and is composed of approximately 80 per cent calcium carbonate. Although it is commonly stained with oil, the chalk does not produce in the field except from fault-plane cavities. The chalk has an average thickness of 168 feet. It is a typical marine formation deposited in moderately deep, warm waters.

Eagle Ford: Two distinct types of Eagle Ford shale are encountered in the Darst Creek field; namely, a jet-black, thinly laminated, lignitic shale, and a grey, thinly laminated, arenaceous shale. Both types are fossiliferous, and almost invariably present a rich show of oil upon penetration. Numerous tests, however, have proved this show valueless. The formation has a fairly uniform thickness of 35 feet throughout the field and, judged from its inclusion of animal and plant remains, seems to be the near-shore phase of marine deposition.

Buda: The Buda is a hard, white, dense, and fairly crystalline limestone. Although it resembles the Austin chalk in some respects, they can be distinguished by the following criteria: (1) the Buda is much harder than the Austin; (2) it is characterized by a scattering of blue-black specks, whereas the chalk is characterized by an abundance of green glauconitic specks; (3) the Buda has a characteristic rectangular fracture, whereas the chalk has not; (4) the Buda contains scarcely any megascopic fossils, whereas they are abundant in the chalk; and (5) the Buda is more dense, brittle, and crystalline than the chalk.

The formation has an average thickness of 70 feet, and is regarded as of true marine origin.

Del Rio: With the exception of several thin layers of *Exogyra arietina* agglomerate, the Del Rio is composed of blue-grey plastic clays. It is entirely different from the overlying and underlying limestone formations, yet its subsurface contact with the two is very hard to determine. This is due to the fact that the upper and lower portions of the formation are sufficiently hard and compact to drill like limestone, whereas only the middle 20 or 25 feet of the formation drills like clay. It is necessary, therefore, to determine the formation contacts from cuttings. The Del Rio has an average thickness of 52 feet, and is considered a comparatively shallow, marine deposit.

Georgetown: This formation consists of alternating beds of hard, blue-grey limestone and somewhat thinner beds of calcareous clays. It is highly fossiliferous, containing an abundance of megascopic and microscopic fossils; namely, *Kingena wacoensis* Hill, *Ostrea (Alectryonia) carinata* ? Lamarck, and *Gryphaea washitaensis* Hill. Although the Georgetown serves as the impervious layer overlying the pay horizon, operators take no chance of water seeping in, and they set casing as near as possible to its base. The formation which has an average thickness of 54 feet, was laid down in near-shore waters of a sea into which clays were washed and deposited along with the limestone.

Edwards: The Edwards formation, the main producing horizon in the field, is composed of a series of hard, crystalline, dolomitic limestones interspersed with lentils and nodules of chert. The upper part of the formation, known as "dobe", is so extremely porous and soft that a roller bit merely sinks through it. The chert, on the other hand, is so hard that it easily wears out a set of roller bit cones in a 8- to 10-inch penetration. Since 4 wells grouped closely around the Texas et al No. 1 Wilson Heirs (Jarmon) encountered practically the same thickness of chert at approximately the same subsurface depth, and since the chert cannot be correlated over long distances, it is evident that the chert is lenticular. Since some wells showed water without penetrating any chert lentils, and other wells did not show water after penetrating four lentils, it is believed that the lentils have little or no control over the oil-water level. A number of wells, in fact, had to drill through several lentils in order to obtain a reasonable initial production.

Although the Edwards is approximately 700 feet thick, the average penetration of the formation by wells is only 28 feet. The maximum penetration is by wells in the middle of the field where it amounts to 55 feet. The purity of the limestones and the presence of corals and other fossils in it indicate its deposition in warm waters.

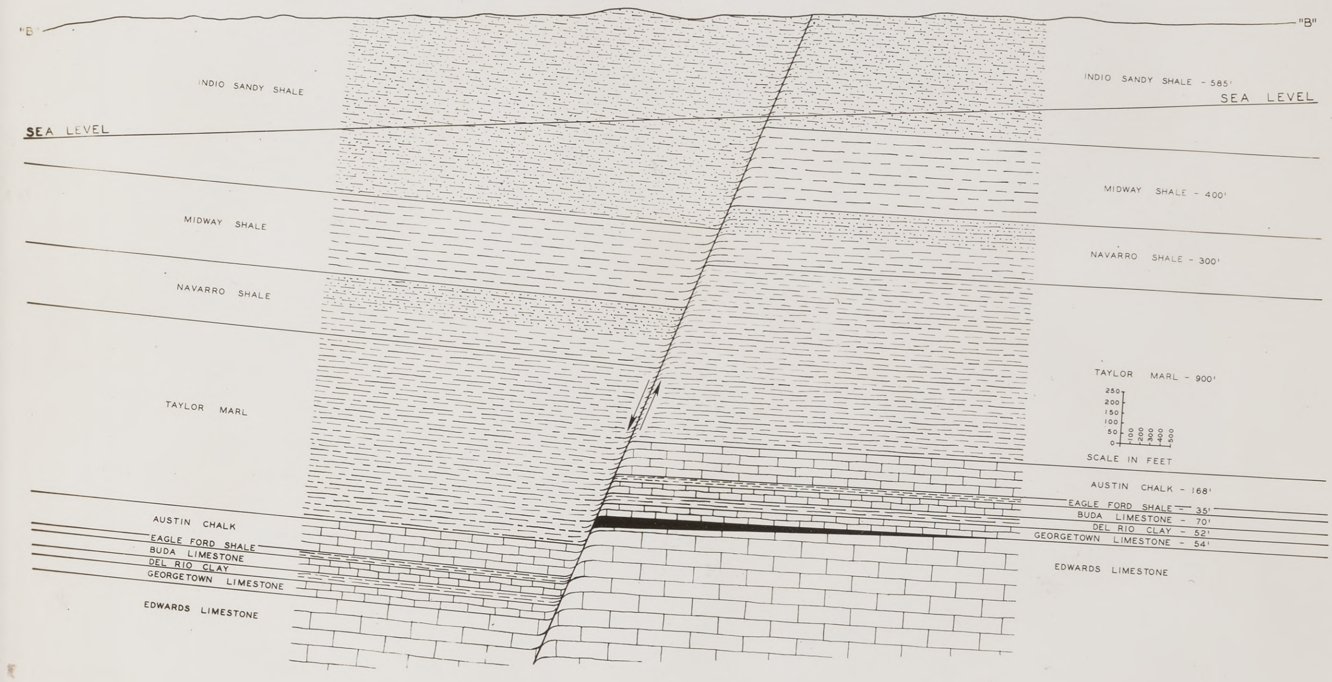

Fig. 4. Cross section B-B (Plate 1) Darst Creek field, Guadalupe County, Texas.

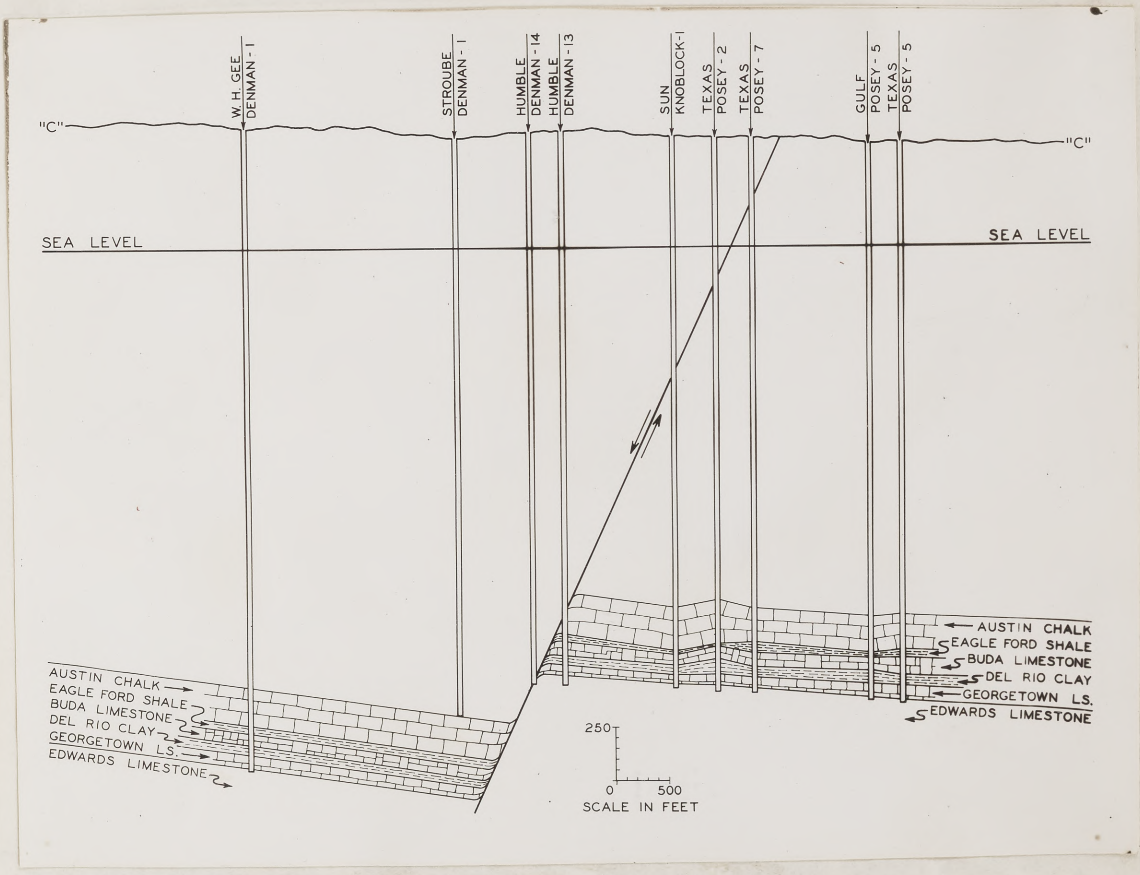

Fig. 5. Cross Section C-C (Plate 1) Darst Creek field, Guadalupe County, Texas.

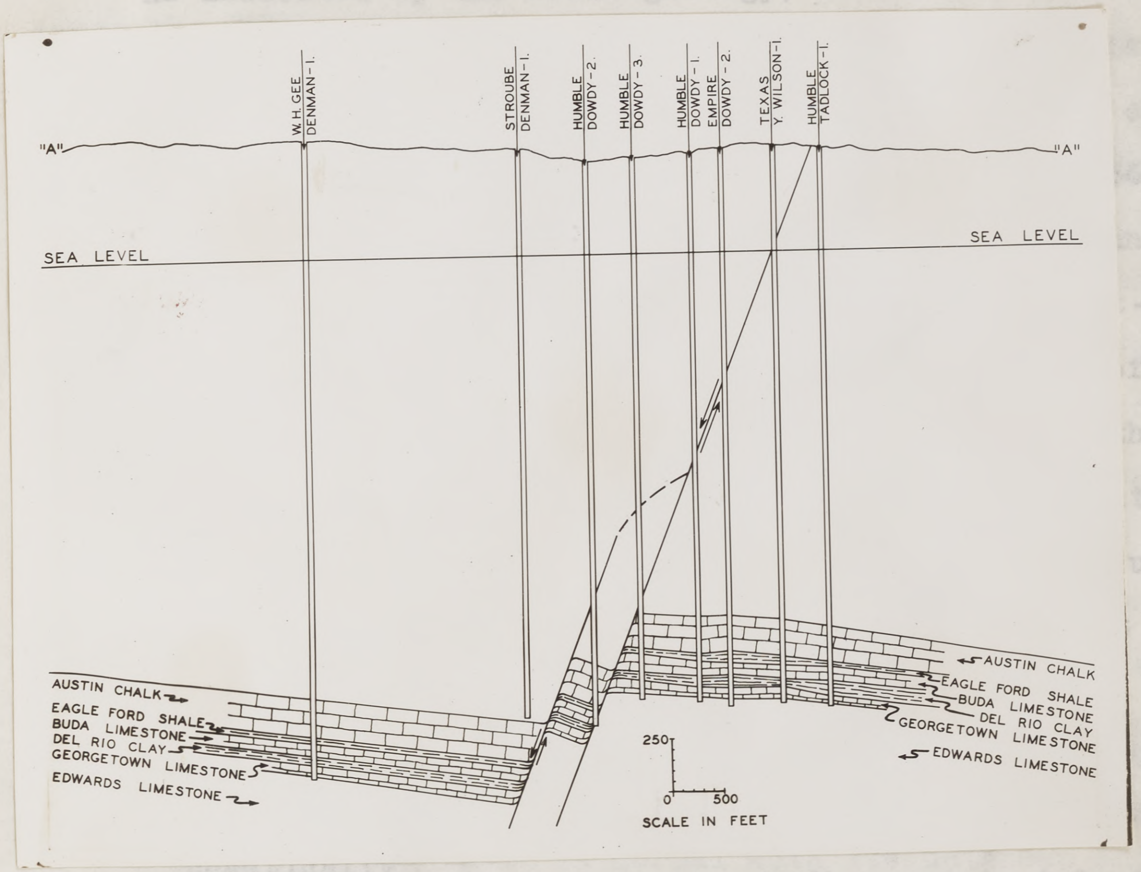

Fig. 6. Cross Section A-A (Plate 1) Darst Creek field, Guadalupe County, Texas.

STRUCTURE

As indicated by the areal geology, subsurface well data have proved that the Darst Creek field resulted from a faulted monocline. The maximum displacement along the fault is calculated on top of the Austin chalk to be approximately 550 feet. This displacement was computed from the Stroube and Stroube No. 1 Mrs. L. G. Denman, which was abandoned at -2192 feet without encountering the Chalk, and the Humble Oil & Refining Company's No. 23 Mrs. L. G. Denman, which encountered the Chalk at -1649 feet, or 543 feet higher than the depth at which the Stroube well was abandoned. The displacement usually occurs in one break (Figure 5); yet in several areas it is known to be divided into at least two breaks (Figure 6). These areas were proven by the Hager et al No. 1 Bibbs, and the Humble Oil & Refining Company's No. A-2 Dowdy, both of which encountered practically full sections of Austin chalk approximately 275 feet higher than normal downthrown Chalk, yet 275 feet lower than normal upthrown Chalk. Since the displacement of the fault is known to approximate 550 feet in some areas, it is logical to assume that either the 550 foot displacement has decreased to 275 feet in the Bibbs and Dowdy areas, or that it is divided between two faults, each having an approximate displacement of 275 feet. This latter explanation seems more logical not only because the Humble Oil & Refining Company's No. A-3 Dowdy was approximately 275 feet higher than the Humble Oil & Refining Company's No. A-2 Dowdy, which in turn was approximately 275 feet higher than the Stroube and Stroube No. 1 Mrs. L. G. Denman, (Figure 6), but also because the Bibbs area is located just opposite the highest area in the field, and it is not logical to assume that there is a 275 foot fault opposite this area when there is a 550 foot fault opposite structurally lower areas. The only other areas where the fault displacement seems divided are on the northeast and southwest extremities of the field. At these points it seems only natural that minor fractures have broken from the main fault and partly account for its diminishing displacement. Just beyond the northeast extremity of the field, the main fault splits, one continuing N. 48° E. for an indefinite distance, and the other turning N. 70° E., passing through the Appling and Echols areas, and explaining the crevice wells there.

The Darst Creek fault is normal with its upthrown side to the southeast. It dips 65° to the northwest, and beginning at the extreme southwestern end of the field, its strike varies little from N. 35° E. for a distance of 5 miles. At this point it cuts downdip forming northeast closure to the field. Closure is formed on the southwest by the downdip strike of the fault gradually making the area too low structurally to produce. It is formed on the northwest by the abutment of the pay horizon with impervious marls, and on the southeast by the regional Edwards dip of 220 feet per mile.

There are three main reasons for believing the Darst

Creek structure resulted from the subsidence of the downthrown side of the fault, rather than from the uplift uf the upthrown side.

First, if the field had been faulted up, the dip of the formations on the upthrown side would be materially steeper than the dip of the formations in the surrdounding area. This is not the case; in fact, with the exception of the southwestern end of the field, the 220 foot per mile dip of the Darst Creek formations is slightly flatter than that of the surrounding area. The accentuated dip on the southwestern end of the field (Plate 1) is required by the subsurface information from several fairly low wells and one extremely low well. It is believed, however, that the extremely low well, and consequently the plunging off on the southwestern end of the field is possibly due to a crooked hole, but probably to the location of the well on the downthrown side of a small fault. This fault may be entirely separate from the Darst Creek fault, or it may have split from the Darst Creek fault in the vicinity of the Camp et al No. 1 Sue E. Denman well.

Second, three or more wells have encountered the basal 300 foot section of downthrown Taylor and proved that this section is much harder than the same section of upthrown Taylor. This hardness may be explained only by metamorphism incurred from the heat and pressure accompanying movement, and as the upthrown side shows little or no metamorphism, it is assumed that the upthrown side did not undergo movement. Wells which furnished this information are Camp et al No. 1 Sue E. Denman, Empire Gas & Fuel Company's No. 3 Chris Knoblock, Humble Oil & Refining Company's No. 13 Mrs. L. G. Denman, and others.

Third, regardless of whether the downthrown side subsided or the upthrown side was uplifted, it is the writer's opinion that neither would do so regularly over a very large area. In fact, local areas varying in power to resist the movement would cause innumerable highs, lows, and faults on the side which was moved. Since the writer believes this would be the case, and since wells have proved the regularity of the upthrown side, it is assumed that the downthrown side is irregular and that its subsidence caused the Darst Creek structure.

The age of the structure is known only to be later than Carrizo-Tertiary time.

PRODUCING HORIZONS

Although wells in the Darst Creek field produce from three distinct horizons, it is believed that all ~~of~~ the oil is from the same source.

First is the Edwards limestone, the main producing horizon of the field. The oil is found in the upper porous zone of this formation, which was described under <u>Stratigraphy</u>. With the exception of an area on the Christopher Knoblock tract, this upper zonemaintains a fairly uniform porosity throughout the field. On this tract, however, six wells came in with unusually large initial productions, and were attributed to additional porosity or to small complex fractures in the pay horizon, rather than to a connection with the main fault plane as enlarged initial productions are usually ex - plained.

Second are the oil producing cavities in the Taylor and Austin formations. These cavities were formed in the non-plastic, metamorphosed Taylor marl and Austin chalk by the main fault; and as both formations are impervious, each is capable of sealing the cavities and trapping the oil which escapes from the Edwards limestone and migrates up the fault plane. The 19 wells which have produced from cavities seem to be confined to minor faults which split from the main fault at the extremities of the field, or to the main fault where it makes abrupt changes in strike. It is interesting to note that wells drilled into these cavities usually get a large initial production, yet some get only a show of oil, and a few are dry. This, of course, depends upon the size of the cavity, the amount of oil trapped therein, and the hydrostatic pressure.

It is necessary to take extra precautions with cavity wells which have a large initial production as their rate of flow is not due to an unlimited supply of oil, or to gas which causes the oil to flow rapidly, but to the hydrostatic head. This head of water, being less viscous, tends to cone the oil aside, thereby disturbing the oil-water level and ultimately destroying the well. This may be prevented, however, by choking the well to a steady moderate flow, and thus leaving the oil-water level undisturbed. By confining these wells to a steady moderate flow, they are likely to produce more oil than normal Edwards wells, and after cavity production has ceased, wells located high enough on the structure may be deepened to the Edwards for additional production.

Third are the reworked serpentine deposits encountered on the extreme northeast end of the field. Two wells are supposedly producing from this substance in an area where at least four additional wells encountered serpentine. It is believed, however, that these wells produce from cavities not only because they are located on the end of the field where minor faults split from the main fault, but because the serpentine encountered was hard, dry and reworked.

The chief significance of the serpentine is that it is probably indicative of a nearby plug. It was deposited during Austin chalk or early Taylor times.

SOURCE OF OIL

Since the oil from the three horizons is practically the same, it is thought to be from the same source. Four main theories have been advanced to account for its origin and are as follows: first, that the oil originated in some deep-seated beds, later migrating up the fault plane into its present position within the upper Edwards limestone; second, that the oil originated in the downthrown petroliferous Eagle Ford shale, later migrating across the fault plane into the abutting Edwards; third, that the oil had its origin in downthrown Taylor marl which was faulted into juxtaposition with the Edwards limestone into which it migrated; and fourth, that the oil is indigenous to the Edwards limestone. These theories have all been discussed in previous papers,[3] and each of the last three has considerable merit. The writer's preference, however, is that the oil is indigenous to the Edwards limestone. This preference is based on the fact that the oil is found in the Edwards limestone, and that there have been numerous reports of asphaltum and other bituminous matter found in the surface outcrop of the Edwards. As further corroboration, Richard Jones states in an article entitled "Surface and Subsurface Characteristics of the Edwards Limestone",[4]

> "An interesting feature of the analysis is that the main pay zone beneath the 'dobe' contains 20.6% of organic material. Oil originates from decomposed organic matter, both of plant and animal nature; and the analysis shows that in the Salt Flat Field organic material comprises one fifth of the producing limestone, a significant fact."

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[3] L. F. McCollum, C. J. Cunningham, and S. O. Burford, "Salt Flat Oil Field, Caldwell County, Texas," Bull. Amer. Assoc. Petrol. Geol., Vol. 14, No. 11 (Nov. 1930), and Ernest W. Brucks, "The Luling Field, Caldwell and Guadalupe Counties, Texas," Bull. Amer. Assoc. Petrol Geol., Vol. 9, No. 3 (May-June, 1925).

[4] Oil Weekly, Sept. 1931, p. 19.

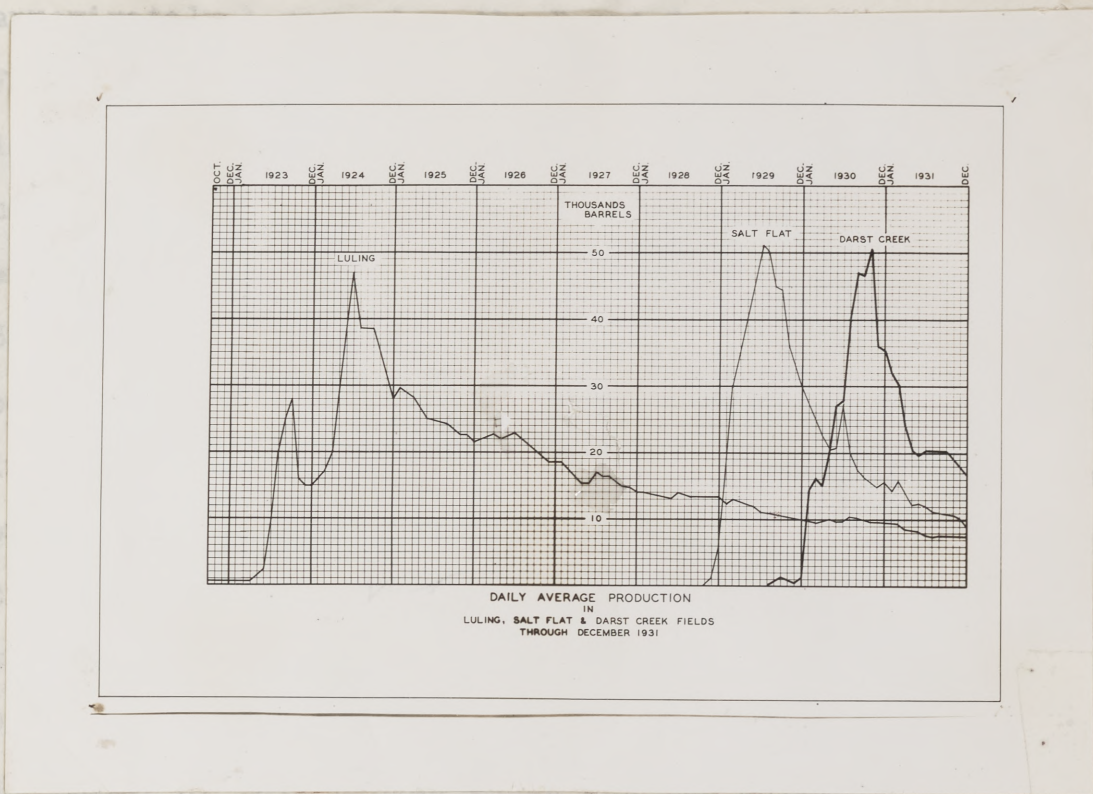

Fig. 8. Daily average production curves for Luling, Salt Flat, and Darst Creek fields, Caldwell and Guadalupe Counties, Texas.

OIL, GAS, AND WATER DATA

The Darst Creek field produced a total of 19,700,340 barrels of pipe line oil through December, 1931. The field has a total of 1670 proven productive acres which have yielded an average of 11,797 barrels of oil per acre. This yield per acre seems low in comparison with the 26,294 barrel yield per acre for the Luling field, and the 20,677 barrel yield per acre for the Salt Flat field, but this low yield is due to the youth of the Darst Creek field. The Luling field had been producing approximately 7 years, and the Salt Flat field aproximately 1 year when the Darst Creek field came in. Furthermore, the acreage in the Luling and Salt Flat field is fully developed, whereas that in the Darst Creek field is not yet completely developed. It is the opinion of the writer, however, that Darst Creek will ultimately produce 35,000 barrels of oil per acre, and exceed the estimated yield per acre of the Luling and Salt Flat fields. This estimated increase is primarily due to the improvement of drilling and production methods since the Luling field was developed, to the more orderly development of the Darst Creek field than of the Luling and Salt Flat fields, and to a thicker pay in the Darst Creek field than in the Salt Flat field. Considering the total of 1670 proven acres and the estimated yield per acre, Darst Creek should have an ultimate production of 58,450,000 barrels. The oil from the field has a deep green color, an average specific gravity of 36° Baumé, and a paraffin base.

TABLE I[5]

Analysis of crude oil from The Texas Company's No. 1 Dallas Wilson, Darst Creek field, Guadalupe County, Texas.

Gravity °API @ 60°	36.7
Water & sediment by centrifuge % by vol., (ASTM D-96-28)	0.1
Water % by vol. (ASTM D95-28)	Trace
Sulphur % by wgt. (ASTM D129-27)	0.78
Color.	Dark Green
Pour Point °F (ASTM D97-28)	30
Say. Univ. Vis. @ 30 °C (86 °F)	51
" " " " 40 "(104 ")	46
" " " " 50 " (122 ")	43

Distillation Yields:

	Temp. °F.	Per-cent	Grav. °API	Flash °F.	Fire °F.	Pour Point °F.	Saybolt Univ. Vis. @100 °F.
Gasoline	397	23.3	58.2				
Kerosine	496	15.0	44.7	162	182		
37-40 Distillate .	528	5.0	40.5	215	245		
Residue		55.7	26.8	310	350	65	242 Sec.
Loss		1.0					
		100.0	Color of Residue - Dark Green				

[5]Analysis through courtesy of A. W. Weeks, Shell Petroleum Corporation, San Antonio, Texas.

Some of the oil, usually in the form of an emulsion, requires a simple treatment with a commercial treating compound before being accepted by pipe line companies. There are four pipe line companies serving the field with a combined capacity of 58,000 barrels daily.

TABLE II

DARST CREEK PIPE LINE OUTLETS

COMPANY	Size (Inches)	Capacity (Barrels)	Terminal
Gulf Production Co.	6	10,000	Crosby, Main line to Port Arthur
Humble Pipe Line Co.	6-8	24,000	Luling tank farm.
Magnolia Petroleum Co.	4	9,000	Luling tank farm.
Texas Pipe Line Co.	6	15,000	Rosanky, Main line to Port Arthur
TOTAL		58,000	

The price of the oil has varied from a low of $0.20 per barrel during part of July, 1931, to a high of $1.15 per barrel during April, 1930. The present, January, 1932, price is $0.60 per barrel.

Gas containing a small percentage of H_2S is associated with oil, and, along with the hydrostatic ~~and rock~~ pressure, accounts for the initial flowing of wells. Considering an equal development in all parts of the field, central and western parts flow much longer than the eastern. This is due to a thicker pay, to perhaps a greater penetration of the pay, and to more gas associated with the oil in these parts. Western edge cavity wells flow chiefly because of the hydrostatic pressure behind the oil, and because of the absence of any obstacle to prevent the upward migration of the oil.

Shortly after completion, some of the wells produce sulphur water. This is probably due to the non-constant oil-water level which has a tendency to conform to the structure, rather than to an established subsurface depth, and to operators drilling wells too deep into the pay horizon seeking a large initial production. A late oil-water production ratio is not available, yet the proration umpire report of November, 1930, shows the 230 wells within the field had a daily potential of 228,733 barrels of fluid, of which 72,929 barrels was sulphur water.

[6] It is interesting to note that in a study of 10 samples of water taken throughout the field there is a slight difference in the chemical composition of bottom and edge waters. This difference is mainly that bottom water shows a similarity to sea water, whereas edge water shows more similarity to altered connate water. In bottom water the ratio of the chloride ~~(R.N.)~~ to the sulphate and carbonate (R.V.) is 9.38, whereas in 77 different analyses of sea water the ratio averaged 9.35. Edge water analyses showed the chloride to sulphate and carbonate ratio (R.V.) to be almost double the same ratio in bottom water. A sample of water from a crevice well within the field proper showed practically the same ratio and chemical composition as the samples of bottom water. A sample of water from a crevice well in the Appling area, however, was

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[6] Bishkin, S. L., Correlation of Luling Salt Flat and Darst Creek Waters, Humble Oil and Refining Company Laboratory, Houston, Texas.

entirely different from any other type of water within the field.

TABLE III[7]

Analysis of water from the Empire Gas & Fuel Company's No. 2 Mrs. A. E. Dowdy, Darst Creek field, Guadalupe County, Texas.

Radicals	Parts per million	Comparison Data		Ratios	
Sodium	6,538	Primary salinity	76.26	Chloride: Bicarbonate	21.
Calcium	1,000	Secondary salinity	19.40	Bicarbonate: sulphate	13
Magnesium	470	Primary alkalinity	0.00	Calcium: Magnesium	1.29
Chloride	12,600	Secondary alkalinity	4.34	Sodium: Calcium & Magn	3.2
Sulphate	60	Chloride salinity	99.7		
Bicarbonate	988	Sulphate salinity	0.3		
Carbonate	---				
TOTAL	21,656	Hygrogen sulphide	406 ppm		

[7] Analysis by the Humble Oil & Refining Company Laboratory, Houston, Texas.

DRILLING AND PRODUCING METHODS

The similarity between the Darst Creek and Salt Flat fields enabled Darst Creek operators to use a similar type of drilling equipment to that used in Salt Flat. A 21" rotary, 11" x 11" or 12" x 12" twin cylinder drilling engine, 6 inch 3 speed draw works, two 66 H.P. boilers, and two 12 x 6¾ x 16 inch slush pumps might be taken as average equipment. Derricks 96 feet in height and reinforced by relegs are used to drill the wells, the relegs being used on successive wells. After wells are completed, derricks are left standing so they may be used when the wells are put on the beam. A string of 4 inch drill pipe with 2 joints of 6 inch pipe on the bottom is in almost universal use.

Usually, two 21 foot joints of 10-inch casing are cemented with 25 sacks of cement in a 13-3/8-inch hole for surface casing. A 9-7/8 inch hole is then carried down to approximately 2600 feet or as near to the base of the Georgetown limestone as can be judged from cuttings. A string of 7-inch O. D. pipe is set at this depth and cemented with 100 sacks of cement. After drilling into the Edwards a $2\frac{1}{2}$ or 3 inch string of tubing is set close to bottom through which the oil is produced. There is no perforated liner or screen set in the wells as the producing horizon does not cave or crumble. An average of 2 to 3 weeks is necessary to complete the wells. Practically all the wells are pumped by Lufkin, Nutall, or Allis-Chalmers units, however, a Lufkin $5\frac{1}{2}$ inch Herringbone unit driven by a 35-55 H.P. electric motor, through the medium of a V-belt drive, is the most common hook up. Electric energy is supplied by the Central Power and Light Company.

Necessary water for field operations is obtained from the Guadalupe River.

FUTURE DEVELOPMENTS

As the extent of the field has been practically defined by dry holes, there is little chance for an increase in the number of productive acres.

Even though some parts of the field have been intensively drilled, there is still an average of 6.1 acres per producing well. In view of the restricted outlet, the prevailing low price of crude, and the general depressed condition of the oil industry, it is not likely that future developments will reduce this average to less than 5 acres per well.

BIBLIOGRAPHY

Row, C. H., Darst Creek Fault, Guadalupe County, Texas, Bulletin, American Association of Petroleum Geologists, Vol. 13 No. 10, p. 1387.

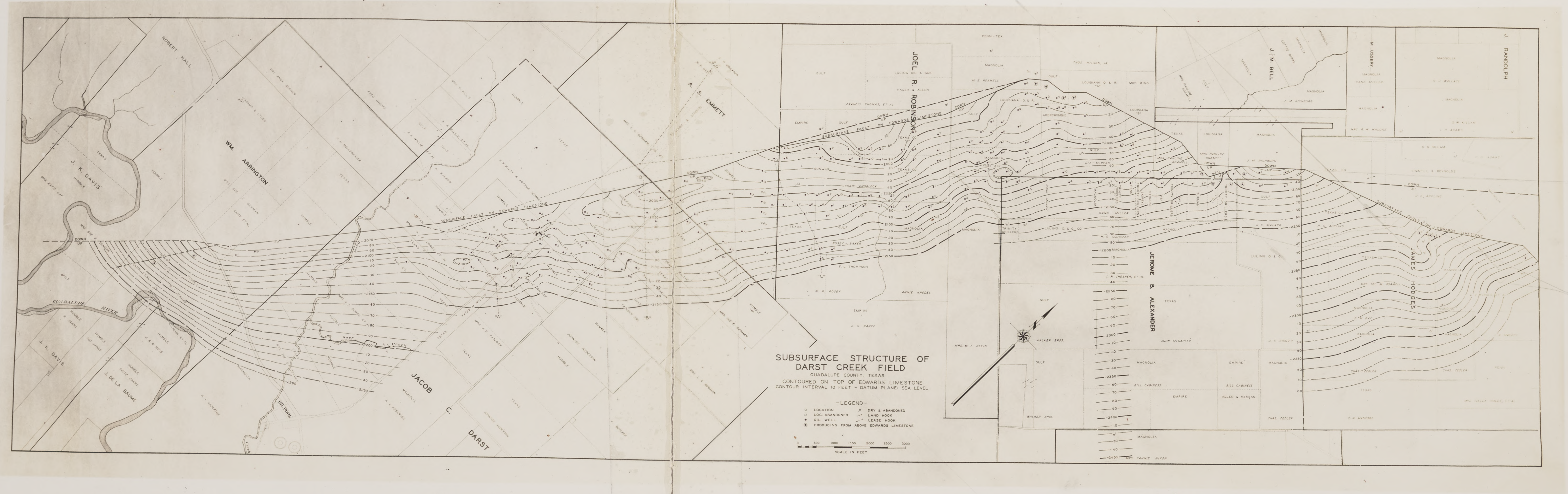
SUBSURFACE STRUCTURE OF
DARST CREEK FIELD
GUADALUPE COUNTY, TEXAS
CONTOURED ON TOP OF EDWARDS LIMESTONE
CONTOUR INTERVAL 10 FEET — DATUM PLANE SEA LEVEL
-LEGEND-
LOCATION
LOC. ABANDONED
OIL WELL
PRODUCING FROM ABOVE EDWARDS LIMESTONE
DRY & ABANDONED
LAND HOOK
LEASE HOOK
SCALE IN FEET
SUBSURFACE FAULT ON EDWARDS LIMESTONE
J. RANDOLPH
M. USSERY
J. M. BELL
JAMES HODGES
JEROME B. ALEXANDER
JOEL R. ROBINSON
A. S. EMMETT
WM. ARRINGTON
JACOB C. DARST
ROBERT HALL
J. K. DAVIS
J. DE LA BAUME
GUADALUPE RIVER

Plate I.